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ABSTRACT

This report describes a study of the effects of using pretests in science classes on chapter test achievement results. The targeted population consisted of eighth grade science students at a junior high school from 1992 to 2001. Whether giving a pretest followed by a posttest at the end of the chapter, or giving only the test at chapter end resulted in superior class averages was investigated. Results show that in all cases giving pretests increased the score on the posttest over the use of the posttest only. A statistical analysis was performed to detect any difference in science test averages for the targeted groups. In three subject areas (Genetics, Chemical Families, and Rocks and Minerals), the null hypothesis was rejected; giving a pretest did increase achievement. For one additional topic, the null hypothesis was supported; the pretest did not increase the achievement score in comparison with the results from posttest alone. It is recommended that the use of the pretest/posttest format be followed, with the objective being a positive effect on student achievement as measured by the Illinois Goals Assessment Test. (Contains 11 tables and 23 references.) (Author/SLD)

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# DO PRETESTS INCREASE STUDENT ACHIEVEMENT AS MEASURED BY POSTTESTS?

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Do Pretests Increase Student Achievement as Measured by Posttest Scores?

By Roger Bancroft

April, 2001

## ABSTRACT

This report describes a comparison of science chapter test achievement results. The targeted population consisted of eighth grade science students from the year 1992 to the present. General Junior High School is located in an affluent middle class community. The problem deals with a comparison of science chapter test averages. Which testing procedure produces superior class averages: Pretest followed by a posttest at the end of the chapter or giving a posttest only at chapter end?

Comments by the school principal and some parents as well as the author's own curiosity prompted this study. Does using a pretest have a significant improvement in class test averages to warrant using the time for a pretest rather than regular science activities? A literature reviews show the use of pretest/posttest for educational research to be wide spread. There was a paucity of information on pretesting as a tool to improve student test achievement.

The results indicate that 100% of the pretests given increased the score on the posttest over the use of posttest only. It is recommended that the use of pretest/posttest format be used. This has the potential to increase posttest scores. A positive effect on the student achievement , as measured on the Illinois Goals Assessment Test, will be the hoped for affect.

Statistical analysis was performed to detect any difference in science test averages of the targeted groups. At this point , the null hypothesis assumes that there is no difference between the groups. In three out of three subject areas, Genetics, Chemical Families, and Rocks and Minerals, the null hypothesis was rejected, i.e., giving a pretest at the beginning of each topic did increase achievement on the posttest given at the end of the chapter. In one topic, the null hypothesis was found to be true. The pretest did not increase the achievement score as compared to posttest only. Discussion on the use of a pretest to improve test scores on a posttest and the proper use of pre/post testing is also found in the report.

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# CHAPTER 1

# PROBLEM STATEMENT AND CONTEXT

## General Statement of the Problem

The students of the targeted eighth grade science classes have been tested using two formats. For the years 1996 through 1999, a pretest was given at the beginning of each chapter. After the lessons, using laboratory activities, written reports,homework, quizzes and a chapter review, a posttest was administered. For the years 1999 through 2001, after all chapter activities, a posttest was given. There was no pretest. The question being asked is: Does a pretest increase the scores on the post test when compared to giving a posttest only?

### Immediate problem Context

General School (hereafter referred to as General) is located in an upper middle class bedroom community of a major city. Homes built in the area of the school are of the same general age as the school. The school has been added to twice in the past twenty five years. In a way, the school has grown up with the community. A third edition is planned, adding eight more classrooms and a new lunchroom.

The General has been in transition to a middle school for the last two years. There are three feeder elementary schools, kindergarten to sixth grades, that send students to the General. In the next two years, the sixth grade will be moved to the General when the building converts to a middle school. Enrollment will rise from the current 376 to 525 students.

As this change is occurring, the principal is retiring and a former assistant principal is returning s the new principal. Currently, this person is serving as a principal of a middle school in a

a community similar to the General's.

The school is divided into three teams. Divided along grade lines,there is one team per grade level with the third team being a mix of the remaining students. Each team utilizes a different area of the building so that contact between different team members, both student and teacher, is limi

Science instruction time per class is 45 minutes. Topics covered in four general areas are listed in Table 1.

Table 1

Science Topic Covered During the School Year

| Topic | Content |
|---|---|
| Earth Science | rocks, minerals,earthquakes,volcanoes |
| Physical Science | chemical families, motion, heat |
| Biological Science | genetics and lab safety issues |
| Environmental Science | Fruitvale Study |
| Rocket Launch | integrated math, science, technology |

Students are asked to do one formal writing assignment. The topic is an answer to the problem "What causes explosive volcanoes to erupt?". There is extensive use of hands-on activities in the form of laboratory experiments. Evaluation of these laboratory papers is done using a 25 point rubric developed locally by the science teacher. Chapter test score, quizzes and homework add to the evaluation mix. Grades are kept by a computer grading program, and students are given grade reports on a weekly basis.

There are no minority faculty members presently at The General. There are about 25 full time faculty plus a number of teacher aides. There are several special education rooms including a Developmental Learning Program group. Teacher and administrator characteristics are all similar to the state averages. It should be noted that teacher salaries fall below the state average while administrative salaries are above the state average. Instructional expenditure per pupil is at the state average.

The Table 1 summarizes the IGAP scores from the school year 1999-2000. Current ISAT score are not available.

Table 2

Illlinois Goals Assessment Program Results

| Test | % meets/ exceeds |
|---|---|
| Mathematics | 59 |
| Reading | 85 |
| Writing | 85 |
| Science | 92 |
| Social Science | 92 |

The summary clearly shows that math is significantly below other tested areas. The General has been engaged in an effort to raise test scores so that the school will rank among the top 5 of the schools in southeast General County.

## The Surrounding Community

The General is 75 % white with a 13% Asian/Pacific Islander population. The remaining percentage is divided between Hispanic and Black students. Low income is a small 6% compared to the state's 36% average. Class size is similar to the the state's average of 23. Table 1 gives the ethnic breakdown and enrollment of the school, district, and state

District demographics mirror State of Illinois data, as can be seen in the following Table 2.

Table 3

Racial/Ethnic Background and Total Enrollment

| | White | Black | Hispanic | Asian/Pacific Islander | Native American | Total Enrollment |
|---|---|---|---|---|---|---|
| School | 75.1% | 4.6% | 6.9% | 13.3% | 0.0% | 390 |
| District | 74.0% | 6.4% | 5.7% | 13.7% | 0.2% | 1,798 |
| State | 62.0% | 20.8% | 13.9% | 3.2% | 0.2% | 1,962,026 |

Table 4

Teacher Education and Pupil Teacher Ratios

| | Average Teacher Experience | Teachers with Bachelor's | Teachers with Master's | Average Teacher Salary | Average Administrator Salary |
|---|---|---|---|---|---|
| District | 13 | 63 | 36 | $41,759 | $79,577 |
| State | 15 | 53 | 46 | $45,337 | $76,917 |

| | Pupil Teacher Ratio | Pupil Certified Ratio | Pupil Administrator Ratio |
|---|---|---|---|
| District | 20:1 | 15:1 | 236:1 |
| State | 19:1 | 14:1 | 243:1 |

The local community uses General School for evening and Saturday sports, which include basketball, soccer and baseball. School facilities are utilized by many community groups.

The funding of the General School District, as listed in the School Report Card, finds the

General District to be spending $1200.00 below the state average of $6600.00 per pupil. Other comparison can be seen in Table 5

Table 5

Illinois Funding Resources

| | Equal Assessed value per pupil | Tax rate per $100 | Instructional Expenses per Pupil | Operating Expenses per Pupil |
|---|---|---|---|---|
| District | $181,682 | 3.12 | $3361 | $5466 |
| State | 163,959 | $3.05 | $3990 | $6682 |

General Town is divided by three elementary districts. General District is one these. General District has three different mailing addresses since town boundaries does not coincide with zip code lines of demarcation. Upon graduation from General School, graduates will attend Hornet or Mustang High as high school boundaries split General Town, north to south. The use of pretest/posttest has surfaced only in the last year because of the principal of General School. The administrator asked the researcher not to use the pretest in targeted science classes. The Principal felt that the idea of pre testing was ineffectual and confusing to parents.

National Context

Pretesting and posttesting is used in numerous studies, ( Cox and Vargas, 196), Smith and Dangbe, 1991, Subkoviak and Harris, 1984). As a research tool for comparing before and after treatments, it is unquestioned.

The problem, as related to the targeted eighth grade classes is a narrow one. Does the use of pretest and posttest produce greater test averages than using post test only. See Figure I for a visual representation of the problem. Literature surveys have failed to find any specific studies that shed light on the problem. However, a report by Cox and Vargas (1966) and Rachor and Gregory (1996), asked a similar question related to criterion referenced tests. The conclusion reached showed that the results of the two testing formats were sufficiently different to warrant the use of pre testing and post testing, especially when criterion referenced tests are called for. Criterion referenced tests are the type currently in use with the science curriculum

# CHAPTER 2

# PROBLEM DOCUMENTATION

## Problem Evidence

Figure 1 on the following page, compares student achievement using pretesting followed by a posttest to an environment which uses only posttest. The circles represent students being funneled through a typical unit of science. As they proceed through each set of funnels, the circles increase because of the student gains in achievement. It is proposed that taking the same test twice as a pretest and then as a posttest will increase the circle size more than pretest only.

At the beginning of each year a meeting with the targeted school principal is held to discuss class startup and the curriculum. The principal asked that pre/posttesting not be a part of the curriculum. He stated that the technique of two tests were of no benefit to the students. He wanted the teachers to use posttest only. Apparently parents would see the pretest score in the student grade report and assume this was a test grade. These grades would upset the parents and of course the principal is only a phone call away.

To bring the light of day to the principals assertion, test data from the years when pre/posttesting was used up to the last two years when pre/postting was away with, a comparison of pre/posttesting to posttesting only was in order.

The question that is being asked is a narrow one. Can a pretest influence the score on a posttest by increasing the posttest score over what the test taker would have received without the pretest. The literature contains very few references on this narrow point. A search produced

contradictory results. Henson (1970) found that intelligence had a greater impact on posttest scores than pretest. Weimer (1999) observed that several predictor measurements for pretests were higher than for posttest.

It would also be reasonable to assume that performance on the pretest can be used to predict posttest results. That is, high scores on the pretest should mean high scores on the posttest. Yap (1979) found that sample size significantly influence posttest results. In other words, the greater the class size the greater the effect of pretest scores on post test scores.

# CHAPTER 3

# THE SOLUTION STRATEGY

## Literature Review

Evaluation of student progress is always a tough task. An excellent example of an integrated curriculum that includes student evaluations. The subject is social studies but could as easily be any other subject matter including science. The document produced by the Texas Education Agency (1976) list three types of tests. Norm referenced tests are used to judge progress from one year to the next. This type of test an achievement test like the SAT (Standford Achievement Test).

Criterion referenced tests,measure progress toward a specific objective. These are teacher designed tests or tests supplied by the publishing company to be used with the book chapters. The Illinois Goals Assessment Program test may be a test of this type.

The final option given by this paper is an informal teacher constructed test. This type can be of a criterion referenced type as long as it relates significantly to the specific subject matter. Any of these could be used as a pretest/posttest format.

Criterion referenced tests were the norm in educational instutions. The question that needs answering is, whether or not the students have gained knowledge over and above their knowledge baseline? Since only a posttest is used, there is no means of finding out how much the students have gained.The use of pretest/posttest is a technique that can measure real gain. The same set of questions were used twice but arranged in a different order. These tests were given at the beginning of the chapter (pretest) and at the end of the chapter (posttest). Students received two grades, (one for the posttest and one based on the difference between the two tests.) The student's

test average includes a part based on a criterion reference test and a part based upon actual improvement of knowledge over a student's knowledge base.

Pretest/posttest use abounds in the educational and science literature. Donaldson (1992) used these tests in a Title One reading and mathematics program in Columbus (Ohio). In a paper by Gribbons and Herman (1997), pretest/posttest was compared to posttest only format. Their conclusion was that the choice of test type for class use depends on the purpose of the evaluation. The authors recommend that multiple evaluation methods be used in the grading of students. The authors did not make any conclusion on the effect of the pretest on the scores students achieved on the posttest. Denton (1974) suggests ways of making good pretests which he calls preinstructional testing.

Huck, Cormier, and Bounds (as cited in Bennett, 1983) state that the simplest test design in research is a pretest/posttest control group design. Using pretest/posttest system is simple to use and execute. It takes about twenty minutes of class time to administer the pretest and thirty minutes for the posttest.

Bennett (1983) then used the two test scenarios on a control group and a treated group. This is very reminiscent of science research. Then to judge if the treatment had any effect over the control group, the author subjected the results to a rigorous statistical test called the t-Test of Independent Means. Analysis of Covariance was also used with the pretest data serving as the cavariant. Again the focus of the paper was on which statistical test may have an advantage over the other in order to see if the treatment made a significant difference in treatment effect. The conclusion the author found was ambivalent. It is recommended by Raffeld (1997) that the pretest/posttest difference of the control group be subtracted from the experimental pretest/posttest difference.

## Project Objective and Processes

Student test scores for pre/posttesting were obtained from grade records for the years 1995-1998. These were score were the raw number correct counts and not precentages. Posttest only scores from the school years 1999 to 2001 were also obtained. The three test topics were chosen because of the completeness of class records. Sample tests for these topics can be found in Appendix B. Student data is from science classes of the General School at the eighth grade level. To protect student confidentiality, scores were reported by student identification number. Each

class of student scores were averaged and all class averages can be viewed in Tables 6 and 7.

Table 6

Class Averages of Pretest Followed By a Posttest

| Genetics | Rocks and Minerals | Chemical Families |
|---|---|---|
| 25.3 | 18.65 | 21.43 |
| 25.3 | 21.43 | 21.43 |
| 37.75 | 17.17 | 16.77 |
| 23.68 | 38.63 | 40.26 |
| 27.33 | 36.44 | 36.07 |
| 20.75 | 42.53 | 38.21 |
| 40.00 | 40.48 | 33.59 |
| 46.48 | 44.07 | 28.91 |
| 38.96 | 39.84 | 38.21 |
| 60.61 | 39.84 | |
| 20. | | |

Table 7

Class Averages of Posttest Only

| Genetics | Rocks and Minerals | Chemical Families |
|---|---|---|
| 21.93 | 21.10 | 23.93 |
| 22.03 | 18.32 | 18.37 |
| 28.03 | 18.40 | 18.18 |
| 20.19 | 18.40 | 18.18 |
| 21.16 | 23.10 | 18.18 |
| 21.16 | 23.10 | 15.40 |
| 20.42 | | |
| 17.12 | | |

For purposes of statistical the testing, the null hypotheses states that there is no difference between the mean scores of the post test when using either pretest/posttest design of posttest only design. The alternative hypothesis is: a pretest increases posttest scores when compared to giving a posttest only.

Methods of Assessment

Tables 8, 9, and 10 report the averages by topic. Data needed for an Independent samples t-Test is found at the bottom of each of the three tables.

Table 8

Rocks and Minerals t-Test Work Sheet

| | Class Averages | |
|---|---|---|
| | Rock and Mineral Posttest Only | Rock and Mineral Pretest and Posttest |
| | 21.10 | 18.65 |
| | 18.32 | 21.43 |
| | 18.40 | 17.17 |
| | 18.40 | 38.63 |
| | 23.10 | 40.48 |
| | 23.10 | 42.53 |
| | 19.71 | 40.48 |
| | | 44.07 |
| | | 39.84 |
| Sum of x | 142.13 | 299.24 |
| Sum of $x^2$ | 2913.65 | 10898.84 |
| n= | 7 | 10 |
| Mean | 20.3 | 9.32 |
| Standard Deviation | 2.15 | 10.89 |

Table 9

Genetics t-Test Work Sheet

| | Class Averages | |
|---|---|---|
| | Genetics Post Test Only | Genetics Pretest and Posttest |
| | 21.93 | 25.30 |
| | 22.03 | 25.30 |
| | 28.03 | 37.75 |
| | 20.19 | 23.68 |
| | 21.16 | 27.33 |
| | 21.16 | 20.783 |
| | 26.85 | 40.00 |
| | 21.16 | 46.48 |
| | 20.42 | 38.96 |
| | 17.32 | 63.15 |
| | | 46.48 |
| | | 63.15 |
| | | 60.61 |
| | | 20.96 |
| Sum of x | 160.58 | 539.93 |
| Sume of $x^2$ | 4940.68 | 23972.12 |
| n= | 10 | 14 |
| Mean | 22.05 | 23.13 |
| Standard Deviation | 3.15 | 15.56 |

Table 10

Chemical Families t-Test Work Sheet

| | Class Averages | |
|---|---|---|
| | Chemical Families Posttest Only | Chemical Familiesl Pretest and Posttest |
| | 21.10 | 18.65 |
| | 18.32 | 21.43 |
| | 18.40 | 17.17 |
| | 18.40 | 38.63 |
| | 23.10 | 40.48 |
| | 23.10 | 42.53 |
| | 19.71 | 40.48 |
| | | 44.07 |
| | | 39.84 |
| Sum of x | 142.13 | 299.24 |
| Sum of $x^2$ | 2913.65 | 10898.84 |
| n= | 7 | 10 |
| Mean | 20.3 | 39.32 |
| Standard Deviation | 2.15 | 10.89 |

# CHAPTER 4

# PROJECT RESULTS

## Historical Description of the Intervention

The intervention in this project was to give students a pretest prior to the commencement of any science activities .The test results were almost invariably a failure for all who took the pretest. Every now and then, a student was noted who received a grade of D on the pretest. After all the science lesson that cover the subject matter were completed and a written review of the subject matter was given to the targeted classes, a posttest was administered. The pretest and the postest are recorded in the electronic grading system. These grades will appear on the weekly grade report that each student of the targeted classes receive.

The use of these grades enabled me to answer the problem posed in this paper. The data The test scores were printed out and instead of name, a student identification number was attached. This should keep student name anonymous so that parent permission need not be sought.

The data was averaged for each class. The averages of all targeted classes were compared in tables of data. A t-value was computed and compared to a table of t-values. Acceptance or rejection of the null hypothesis was noted. If the null hypothesis was rejected then the alternative hypothesis was used.

## Presentation and Analysis of Results

t-Values were calculated from the data and then compared to a table of t-values found in Appendix C. Table 11 summarizes the results of this statistical comparison.

Table 11

Summary of distribution for Correlated Samples Design

| | Calculated t-Values | Table t-Values | Result of Comparison |
|---|---|---|---|
| Rocks/Minerals | 4.21 | 1.345* | Null Hypothesis Rejected |
| Genetics | 1.20 | 2.07 | Null Hypothesis Rejected |
| Chemical Families | 12.65 | 1.75* | Null Hypothesis Rejected |

*P < .05

The null hypothesis, there is no difference between the means of the pre/posttest and posttest only groups is rejected in all of the three subject areas listed in Table 10, i.e., there is a difference between the means of pretest/posttest and posttest only formats. If the table value is less than the calculated t-value then the null hypothesis, i.e., no difference between means, is accepted. As can be seen from Table 10, the three topics, Rocks and Minerals, Rocks and Minerals, and Chemical Families, there is a significant difference, at the 95% level. There is an increase in student achievement when a pre test is given at the start of a topic when the same test is used as a post test.

Three out three topics were found to significantly increase posttest scores when the students were given a pretest prior to the science activities. Two conclusions come to mind. First, giving a pretest prior to the start of a new topic increases post results 66% of the time. Second, more subject areas need to be looked at before a definitive conclusion can be stated. Since some is better than none I would use pretests as part of the evaluation of student achievement.

## Conclusions and Recommendations

Since my work uses science test results, it is a good idea to compare science research terms to educational research terms. A pretest is given to one or two groups. An intervention is imposed on one group. A posttest is administered to determine if the intervention had any effect. In some studies a control group is used with no intervention. These are the basics of educational research.

In a study of the effects of two pesticides on the the development of Xenopus laevis (South African clawed toads) Bancroft and Prahlad (1972) found several developmental defects in adult

frogs. In this piece of science research, the pretest would be called the control. These are control animals were reared side by side with the treated toads thus experiencing the same environmental factors as the treated animals, with the single exception of the pesticides. The posttest in the instance of this research are pictures of the treated animals which are then compared to pictures of the control group. Any observable differences are then due to the treatment (pesticides).

The differences observed included blindness, balance organ abnormality and accordion shaped backbone. These are, for the animal, significant affects. These effects were seen in all animals that were treated so no statistical test was applied. This is the main difference between this study and the science research paper.

Thus both science and educational research have the same basic parts. Yes, based on the evidence presented in this action research, the targeted class did benefit from the use of a pretest.

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Appendix A
Samples of Test Questions Used to Produce Pre and Post Tests
A Computer Driven Test Authoring Program is Used to Produce These Tests.

Name_____Class___

# CHAPTER 4 ROCKS AND MINERALS TEST

Please place all answers in the space provided in the left hand margin.

Multiple Choice Questions

____1) The size of crystals depends mainly on
(A) the presence of air. (B) pressure.
(C) cooling rate. (D) the presence of water.

____2) Which of the following is a nonmetallic mineral?
(A) sulfur (B) lead (C) coppper (D) aluminum

____3) Which of the following is an example of a sedimentary rock?
(A) conglomerate (B) obsidian
(C) granite (D) marble

____4) Rocks that form when great heat, pressure, and chemical reactions change existing rocks are called
(A) metamorphic rocks. (B) mudrocks.
(C) sedimentary rocks. (D) igneous rocks.

____5) The luster of a mineral describes
(A) its color.
(B) the way it reflects light.
(C) its density.
(D) its ability to resist being scratched.

____6) Which of the following describes minerals?
(A) liquid. (B) organic.
(C) definite composition. (D) synthetic.

____7) Rubbing a mineral sample across unglazed ceramic tile is the usual way of determining
(A) luster. (B) density. (C) hardness. (D) streak.

____8) Rocks that form from magma are called

(A) igneous rocks. (B) metamorphic rocks.

(C) sedimentary rocks. (D) clastic rocks.

____9) Which of the following is an example of a metamorphic rock?

(A) granite (B) marble (C) breccia (D) obsidian

Fill-in-the-blank questions

____10) The breaking of a mineral along smooth, flat surfaces forming angles is called_____.

____11) Naturally occurring solids made of 2 or more minerals are called_____.

____12) The 1 to 10 hardness scale in which the number 1 is assigned to talc is called_____

____13) Small pieces of rocks, shells, or plant or animal remains carried and deposited by wind, water, and ice are called _____.

True and False questions: If the statement is false, replace the underlined word with a word that will make the statement true.

____14) When magma cools rapidly, large crytals are formed.

True / False

____15) The changing of one rock type into another as a result of heat, pressure, and chemical reactions is sedimentation.

True / False

____16) A mineral with a hardness of 6 will scratch a mineral with a hardness of more than 6.

True / False

____17) Rocks formed directly for indirectly from once-living material are called organic rocks.

True / False

____18) The continuous changing of rocks from one type to another is called the rock cycle.

True / False

Use the diagram provided to help answer the following questions.

____19) What would happen if a piece of fluorite were rubbed against a piece of feldspar?

____20) An unknown mineral is found to scratch apatite and to be scratched by corundum. What can be said of this mineral's hardness?

____21) Which mineral is the hardest? What does this mean?

____22) What would you expect to happen if a mineral of hardness 7.5 were rubbed against a piece of quartz? Against a piece of topaz?

**USING SCIENCE SKILLS: Making Comparisons, Identifying Relationships**

| Mineral | Hardness |
|---|---|
| Talc | 1 |
| Gypsum | 2 |
| Calcite | 3 |
| Fluonte | 4 |
| Apatite | 5 |
| Feldspars | 6 |
| Quartz | 7 |
| Topaz | 8 |
| Corundum | 9 |
| Diamond | 10 |

# WHAT IS GENETICS? 8TH GRADE CHAPTER TEST

**ALL ANSWERS ARE TO BE PLACED IN THE MARGIN ON THE LEFT HAND SIDE OF THE TEST PAGES.**

____ 1. A word that means a characteristic of an organism is

A. pattern. B. tallness. C. trait. D. factor.

____ 2. If genes for white flowers mask genes for red flowers, the "red" genes are

A. recessive. C. dominent.

B. hybrid. D. incompletely dominant.

____ 3. When true-breeding tall plants are crossed with hybrid tall plants, the offspring are

A. all tall plants.

B. all short plants.

C. some tall and some short plants.

D. not enough information has been given to answer this question.

____ 4. The parents of three boys are having another child. What is the probability that the child will be a girl?

A. 25 percent B. 50 percent C. 75 percent D. 100 percent

____ 5. The visible traits of an organism are its

A. mutations. B. phenotype. C. hybridization. D. genotype.

____ 6. If a plant has round seeds and the genotype Rr, the r stands for

A. dominant characteristics. C. gene for roundness.

B. hybrid. D. gene for wrinkledness.

____ 7. The units of heredity that determine, for example, whether a plant is tall or short are called

A. hybrids. C. dominant characteristics.

B. genes. D. determiners.

____ 8. If purebred red flowers are crossed with purebred white flowers and the offspring are all pink flowers, the genes for flower color are showing

A. codominance. C. incomplete dominance.

B. hybridization. D. mutations.

____ 9. If pink four-o'clock flowers were crossed, what type of offspring would be produced?

A. all pink flowers

B. red flowers, pink flowers, and white flowers

C. red flowers amd white flowers

D. all white flowers

____ 10. Which was not a reason for using pea plants to study inheritance?

A. Pea plants have only one visible trait, which makes them easier to study.

B. Pea plants grow quickly.

C. Many generations of pea plants can be observed in a fairly short time.

D. Pea plants can be crossed easily.

FILL-IN-THE-BLANK: CHOOSE ONE OF THE FOLLOWING WORDS TO COMPLETE SENTENCE: GREGORY MENDEL, RECESSIVE, DOMINANT, GENOTYPE, PHENOTYPE, PROBABILITY, HYBRID, PUREBRED.

____ 11. Transferring pollen from the male part of one flower to the female part of another flower is called _____.

____ 12. _____ is called the Father of Genetics.

____ 13. The likelihood that a particular event will take place is called _____.

____ 14. The actual gene makeup of an organism is called its _____.

____ 15. A trait that is masked by a dominant trait is called _____.

TRUE AND FALSE

____ 16. Crossing short plants (tt) with each other produces only short plants.

True / False

____ 17. Taxonomy is the study of heredity.

True / False

____ 18. A recessive gene is represented by a capitol letter.

True / False

____ 19. An organism with the genotype Tt is a purebred.

True / False

____ 20. The law of segregation states that one gene from each pair goes to each sex cell.

True False

USE DIAGRAM AT END TO HELP ANSWER THE FOLLOWING QUESTIONS.

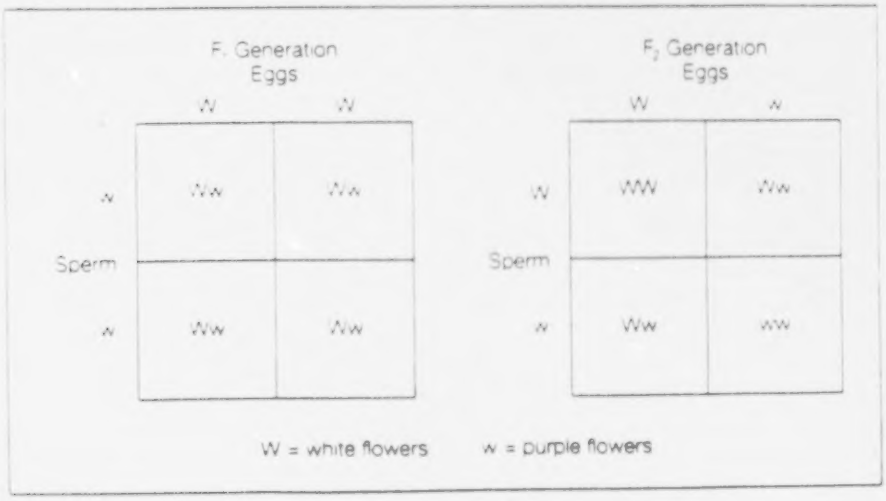
____ 21. Which trait, white flowers or purple flowers, is dominant? Which is recessive? How do you know?

____ 22. In the $F_1$ generation, what are the genotypes of the offspring? The phenotypes?

____ 23. In which generation are the parents true-breeders? In which generation are the parents hybrids?

____ 24. What are the genotypes of the offspring in the $F_2$? The phenotypes?

____ 25. What is the ratio of white to purple flowers in the $F_2$ generation?



# CHAPTER 3 TEST FAMILIES OF CHEMICAL COMPOUNDS

## MULTIPLE CHOICE

____ 1) An alkane with 2 carbon atoms would have the formula

**(A)** $C_2H_2$ **(B)** $C_2H_6$ **(C)** $C_2H_{10}$ **(D)** $C_2H_4$

____ 2) A measurement of how much solute can be dissolved in a given amount of solvent under certain conditions is called

**(A)** solubility. **(B)** strength. **(C)** polarity. **(D)** molarity.

____ 3) If an alcohol and an organic acid are chemically combined, the resulting compound is called a(an)

**(A)** ester. **(B)** aromatic hydrocarbon.

**(C)** lipid. **(D)** halogen derivative.

____ 4) Substances that react with metals to produce hydrogen gas are called

**(A)** acids. **(B)** bases. **(C)** salts. **(D)** tinctures.

____ 5) A substance that does not conduct an electric current is called a(an)

**(A)** nonelectrolyte. **(B)** tincture.

**(C)** aqueous solution. **(D)** electrolyte.

____ 6) The general formula for an alkene is

**(A)** $C_nH_n$ **(B)** $C_nH_{2n+2}$ **(C)** $C_nH_{2n}$ **(D)** $C_nH_{2n-2}$

____ 7) A solution in which the solvent is alcohol is a(an)

**(A)** tincture **(B)** electrolyte.

**(C)** aqueous solution. **(D)** polar solution.

____ 8) An example of an alkyne is

**(A)** propane. **(B)** butene. **(C)** ethylene. **(D)** ethyne.

____ 9) A weak acid has a pH of

**(A)** close to 7. **(B)** close to 0. **(C)** close to 14. **(D)** 7.

____ 10) A solution that contains many dissolved molelcules in a fixed amount of solution is called

(A) weak. (B) concentrated.

(C) dilute. (D) strong.

## FILL-IN-THE-BLANK

____ 11) All organic compounds contain the element _____.

____ 12) A mixture in which a solute is dissolved in a solvent is called a(an) _____.

____ 13) A(An) _____formula shows the kind, number, and arrangement of atoms in a molecule.

____ 14) Two liquids that dissolve each other are said to be _____.

____ 15) A substance that feels slippery and produces hydroxide ions is called a(an) _____.

## TRUE AND FALSE STATEMENTS

____ 16) The rate of dissolving a solid into a liquid is <u>decreased</u> by stirring the solution.

**True / False**

____ 17) A neutral substance has a pH of <u>14</u>.

**True / False**

____ 18) The general formula for an alkyne is $C_nH_{2n-2}$.

**True / False**

____ 19) Acids turn <u>blue litmus paper red</u>.

**True / False**

____ 20) Organis compounds generally have a <u>high</u> melting point.

**True / False**

## USE THE SOLUBILITY-CURVE DIAGRAM TO ANSWER THE FOLLOWING QUESTIONS.

____ 21) Which substance is least soluble at $15^{O}C$?

____ 22) Which substance is most soluble at $20^{O}C$?

____ 23) What is the solubility of $KNO_3$ at $70^{O}C$?

____ 24) How many grams of $KNO_3$ will settle out when a solution is cooled from $70^{O}C$ to $50^{O}C$?

**DRAW STRUCTURAL FORMULAS AND NAME THE MOLECULES BEOW.**

____ 25) Draw a structural formula for $CH_4$.

____ 26) Draw a structural formula for $C_3H_6$.

**IDENTIFY THE COMPOUNDS BELOW AS ACID (A), BASE (B), OR SALT (S).**

____ 27) $Zn(OH)_2$

____ 28) $NH_4Cl$

____ 29) $H_2CO_3$

____ 30) $NaNO_3$

# Appendix B
## The t-Distribution Table

TABLE D The *t* distribution*

| | Confidence interval percents (two-tailed) | | | | | |
|---|---|---|---|---|---|---|
| | 80% | 90% | 95% | 98% | 99% | 99.9% |
| | Significance level for two-tailed test | | | | | |
| | .20 | .10 | .05 | .02 | .01 | .001 |
| | Significance level for one-tailed test | | | | | |
| df | .10 | .05 | .025 | .01 | .005 | .0005 |
| 1 | 3.078 | 6.314 | 12.706 | 31.821 | 63.657 | 636.619 |
| 2 | 1.886 | 2.920 | 4.303 | 6.965 | 9.925 | 31.598 |
| 3 | 1.638 | 2.353 | 3.182 | 4.541 | 5.841 | 12.924 |
| 4 | 1.533 | 2.132 | 2.776 | 3.747 | 4.604 | 8.610 |
| 5 | 1.476 | 2.015 | 2.571 | 3.365 | 4.032 | 6.869 |
| 6 | 1.440 | 1.943 | 2.447 | 3.143 | 3.707 | 5.959 |
| 7 | 1.415 | 1.895 | 2.365 | 2.998 | 3.499 | 5.408 |
| 8 | 1.397 | 1.860 | 2.306 | 2.896 | 3.355 | 5.041 |
| 9 | 1.383 | 1.833 | 2.262 | 2.821 | 3.250 | 4.781 |
| 10 | 1.372 | 1.812 | 2.228 | 2.764 | 3.169 | 4.587 |
| 11 | 1.363 | 1.796 | 2.201 | 2.718 | 3.106 | 4.437 |
| 12 | 1.356 | 1.782 | 2.179 | 2.681 | 3.055 | 4.318 |
| 13 | 1.350 | 1.771 | 2.160 | 2.650 | 3.012 | 4.221 |
| 14 | 1.345 | 1.761 | 2.145 | 2.624 | 2.977 | 4.140 |
| 15 | 1.341 | 1.753 | 2.131 | 2.602 | 2.947 | 4.073 |
| 16 | 1.337 | 1.746 | 2.120 | 2.583 | 2.921 | 4.015 |
| 17 | 1.333 | 1.740 | 2.110 | 2.567 | 2.898 | 3.965 |
| 18 | 1.330 | 1.734 | 2.101 | 2.552 | 2.878 | 3.922 |
| 19 | 1.328 | 1.729 | 2.093 | 2.539 | 2.861 | 3.883 |
| 20 | 1.325 | 1.725 | 2.086 | 2.528 | 2.845 | 3.850 |
| 21 | 1.323 | 1.721 | 2.080 | 2.518 | 2.831 | 3.819 |
| 22 | 1.321 | 1.717 | 2.074 | 2.508 | 2.819 | 3.792 |
| 23 | 1.319 | 1.714 | 2.069 | 2.500 | 2.807 | 3.767 |
| 24 | 1.318 | 1.711 | 2.064 | 2.492 | 2.797 | 3.745 |
| 25 | 1.316 | 1.708 | 2.060 | 2.485 | 2.787 | 3.725 |
| 26 | 1.315 | 1.706 | 2.056 | 2.479 | 2.779 | 3.707 |
| 27 | 1.314 | 1.703 | 2.052 | 2.474 | 2.771 | 3.690 |
| 28 | 1.313 | 1.701 | 2.048 | 2.467 | 2.763 | 3.674 |
| 29 | 1.311 | 1.699 | 2.045 | 2.462 | 2.756 | 3.659 |
| 30 | 1.310 | 1.697 | 2.042 | 2.457 | 2.750 | 3.646 |
| 40 | 1.303 | 1.684 | 2.021 | 2.423 | 2.704 | 3.551 |
| 60 | 1.296 | 1.671 | 2.000 | 2.390 | 2.660 | 3.460 |
| 120 | 1.289 | 1.658 | 1.980 | 2.358 | 2.617 | 3.373 |
| ∞ | 1.282 | 1.645 | 1.960 | 2.326 | 2.576 | 3.291 |

* To be significant the *t* obtained from the data must be equal to or larger than the value shown in the table.

SOURCE: Table III of Fisher and Yates (1963), *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver & Boyd, Edinburgh) and by permission of the authors and publishers.

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